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EXPANDING HIGH GROWTH, TECHNOLOGY-BASED INDUSTRY IN MICHIGAN

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In his State of the State Message, 15 January 1981, Governor William Milliken proposed an economic growth plan to help move Michigan out of the most trying economic situation it has faced since the Great Depression. Key points included several major initiatives to expand high growth, technology-based industry in the state. The Michigan Council of Professional Scientific and Technical Associations (MCPSTA) is eager to help the governor and the legislature implement these initiatives. Because most of the major engineering and technical societies in this state are members of MCPSTA and because these societies have nationwide contacts with prospective high technology industries that could make use of Michigan's unique natural and human resources, the council feels qualified to assist.

This article contains certain recommendations arrived at by a special MCPSTA task force composed of representatives from local high technology industry and from Michigan's major engineering schools. These recommendations expand on the governor's initiatives and also upon specific recommendations embodied in the Burkhalter report to the governor[1] and the somewhat similar Blumenthal commission report.[2] The need to attract high technology industry in order to diversify the Michigan economy has been well known for some time. For example, the Bacon study called for developing strong incentives for high technology industry to locate and grow here.[3] That study specifically cited those industries leading to manufacture of industrial, institutional, and consumer products that are largely electromechanical in nature, but also use some electronics. However, due to the strength of Michigan's automobile industry, no real efforts to nurture diverse high technology industry were made in the 1970s. It is hoped that our suggestions may be viewed as augmenting the governor's plan and the Burkhalter and Blumenthal reports. The fifteen MCPSTA recommendations are noted below.

(1) MCPSTA strongly endorses the governor's concept of a special planning body to develop an accelerated economic action plan. This body should be permanent and contain a full-time staff and board drawn from the private and public sectors and functioning in a role similar to that envisioned for the Institute of Economic Development described in recommendations no. 21, no. 22, and no. 23 of the Blumenthal report. The economic planning body could serve as the synthesizer of all economic data generated by the government, universities, and the private sector; conduct in-depth economic analyses; make policy recommendations; provide long-range economic information and projections; provide support for research related to the development of new industries matched to the state's resources; and provide a closer relationship between our higher educational institutions and the private sector oriented toward economic growth.

(2) MCPSTA also is convinced that an interdepartmental Job Development Coordinating Council, as recommended in the Burkhalter report, should be created. This council would be coordinated by the Office of Economic Development and would serve as the primary coordinat-

ing agency of the various state civil service offices and bureaus whose functions affect employment in Michigan. The council could also evaluate the effectiveness of PA 609 (1978), the Full Employment Act, and make a report to the governor and the legislature.

(3) MCPSTA views as desirable the establishment of a High Technology Educational Council consisting of the six major public engineering schools in the state (University of Michigan, Michigan State University, Wayne State University, Michigan Technological University, Western Michigan University, and Oakland University). This council would ensure that these universities meet the need of high technology industries for advanced continuing education courses and seminars, secure additional financial support for these universities from industry, and enhance joint cooperative research and development efforts between industry and academia. This cooperative effort could also include the rotation of engineering school faculty into industry and senior engineers from industry into academia on a cooperative basis.

(4) Implicit in the governor's State of the State message and in recommendations nos. 11–14 of the Burkhalter report is the assumption that Michigan's engineering universities have the laboratory and faculty capability to cooperate significantly with industry in such ventures as innovation centers or industrial parks. While perhaps true in the 1960s, this capability has severely atrophied in the last decade. Currently, Michigan's engineering schools do not have the faculty capability to develop programs in entrepreneurial studies or engage in any significant amount of industry consulting. Finally, due to lack of graduate students, this state's graduate schools are unable to meet the needs of high technology industry should it locate in Michigan. To rectify these shortcomings, MCPSTA offers three suggestions.

First, there should be increased accountability to the legislature by each of the state's public engineering schools with respect to how these institutions are satisfying the needs of current or prospective Michigan high technology industry. State funding can no longer be automatic for 11-plus engineering schools without some accountability. Furthermore, different disciplines—for example electrical, mechanical, computer, chemical, manufacturing, and so forth—should be emphasized by each of the major schools so that the best possible graduate program exists in at least one or two schools for each engineering discipline. Tax incentives such as credits and deductions for contributions aimed at establishing a laboratory or professional chair should be made available to industry.

Second, a statewide, two-way higher education cable TV network could link the major engineering universities with each other and with high technology industrial sites. This cable network could be via satellite and might also be used for business data communications (see below). Large, high technology companies employing a significant force of blue-collar workers are not going to East Lansing or Ann Arbor. Higher education in Michigan must be prepared to go to potential sites (Grand Rapids, Benton Harbor, Muskegon, Kalamazoo, and Traverse City on the western side of the state, for example). Funding for such a cable TV network could be arranged through state bonds and industrial contributions and use fees.

Third, additional funding should be granted the major engineering schools so that they may employ graduate students full time as teaching assistants at a salary level roughly 50 percent of the current wages being offered by industry to B.S. graduates. This would encourage many more bright students to stay in school and get an advanced degree. Tax credits for industrial contributions to fund additional graduate assistantships should be established. Financial support should also be sought from the National Science Foundation, as this is a national problem.

(5) While the Burkhalter report is correct (recommendation no. 3) in stating the importance of attracting high technology industries to the state, MCPSTA takes issue with the priorities listed in recommendation no. 5, which ranks the attraction of branch industries from outside the state much lower than the creation of start-up businesses within the state. In the high technology business sector, large size alone does not imply static growth. The number of employees working for IBM, Magnavox, TRW, Hughes, and so forth, has not remained fixed, but is growing constantly as these companies expand their technology base. Hence, a branch plant of an established high technology company should be courted as earnestly as the start-up of a new business. In the near term, high technology garage shops, even potential "Texas Instruments," will not adequately take up the employment slack in Michigan due to the contraction of the U.S. automobile industry. Only the infusion of large branch plants can do that within the next five years. It also can be expected that considerable spinoff of small firms will occur from large branch plants.

(6) MCPSTA recommends the establishment of a statewide cable business data communications network. This would permit data exchanges at video rather than long-line rates and would be most attractive to new business. The business data communications network could also serve as the two-way, high technology, educational TV network described above.

As part of the statewide data communications network, the Department of Commerce should set up a data bank of all potential customers for Michigan products, both domestic and international. Furthermore, the department should establish a capabilities data bank of Michigan industry to which potential customers could address inquiries. These customers would be aggressively sought by the Department of Commerce. Through MCPSTA, the professional, technical, and scientific community would assist the department in the creation of such a data

bank. Direct assistance from various industry groups would also be required. The availability of the data bank to Michigan business and potential customers must then be constantly publicized by the Department of Commerce.

(7) In addition to the high technology target industries listed by the governor and the Burkhalter report, sophisticated agricultural equipment and aircraft and defense equipment appear also to be good prospects for Michigan. High technology, agri-engineering equipment would seem to provide an ideal marriage of the state's automotive manufacturing capability to its second leading industry. Furthermore, the state's well-established agricultural engineering schools could play an important part in identifying marketable agri-engineering products to industry. High technology aircraft/defense equipment, including advanced airframes and armored vehicles, would also be good matches to Michigan's capability for heavy durable goods production. The state already has a fledgling aerospace industry, and this should be nurtured.

(8) MCPSTA recommends the governor appoint a committee to review the effect of PA 64 (1979), the Hazardous Waste Management Act, on Michigan industry and on attracting new industry to the state.

While MCPSTA supports the major provisions of the act, certain implementation rules appear to be in conflict with, or considerably in excess of, those of the National Resource Conservation Recovery Act. To the extent that such conflicting requirements only deter responsible high technology industry from moving to Michigan, some modification may be in order.

More generally, MCPSTA feels that Michigan must develop flexible environmental and waste management policies that can respond to changes in any nationally approved requirement. MCPSTA calls for tax incentives to encourage growth in the private sector of the hazardous waste reclamation industry and allied disposal facilities so as to meet the needs of Michigan and the Midwest.

(9) The New Business Development Corporation already approved by the legislature must be organized as soon as possible. This corporation and the technology-based Innovation Development Fund suggested by the governor would raise venture capital for new high technology businesses.

(10) MCPSTA recommends that the legislature approve state tax credits or at least deductions for documented research and development on potential new products, processes, or systems. (The results of the research need not be made public, of course, only the manpower and equipment costs.) An example of such a proposed federal tax credit structure is H.R. 7983 (VanderJagt and Pickle), which would provide a 25 percent tax credit for increases in research and development spending over the average annual research and development outlays of a firm for the previous three-year period. Another proposed federal tax incentive that could be implemented at the state level is H.R. 6632 (Vanik), which would provide a tax credit similar to that in H.R. 7983 to business firms that buy research at colleges and universities. The Michigan legislature might wish to restrict this research to that performed at in-state institutions.

(11) Similarly, MCPSTA recommends state tax credits for expenses incurred in filing patent applications. These credits would only be available to individuals or small businesses, however.

(12) MCPSTA recommends that a legislative committee be set up to monitor the effectiveness of the new Worker's Compensation and Unemployment Insurance Act in eliminating disincentives for high technology industry to locate in Michigan. Certain problems appear to exist in the functioning of the Board of Review brought about by the lack of computer aids to sort out the myriad of cases on file. MCPSTA will join with other groups in making recommendations to ease these administrative problems in the near future.

(13) MCPSTA strongly recommends that the state take advantage of federal matching funds to accelerate innovation. To this end, state funds or bonding approval should not be held up unduly; delays in innovative projects result in increased final costs due to the time value of money and, of course, do not help the current employment situation. The DOE/Michigan Regional Electric Battery Storage Project involving the Wolverine Electric Power Co-Op Company is an example of such a delay due to slow bonding approval by the Michigan Public Service Corporation.

(14) MCPSTA recommends that the solar tax credit be retained and even increased in amount to allow a faster payback than would be possible from placing the equivalent monies in long-term deposits. Similar credits should pertain for use of other forms of alternative energy sources. Extension of these credits will help the small but growing alternative energy industry in Michigan.

(15) MCPSTA strongly supports and will work with the governor and legislature in establishing a consistent Michigan energy policy. Such a policy would ensure that Michigan is able to guarantee a plentiful and economic supply of energy to all prospective industry. Furthermore, this policy would foster cooperation among public utilities, the Department of Natural Resources, and local communities and would avoid frustrating (and costly and nonproductive) construction delays such as those accompanying the Midland nuclear plant.

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[1]Special House Committee on Job Development, *Job Development in Michigan: A Special Report* (Lansing: 1980).

[2]Michigan Economic Action Council, *Toward Growth with Stability* (Lansing: 1976).

[3]Frank R. Bacon, *Planned Innovation* (Ann Arbor; Institute of Science and Technology, The University of Michigan, 1967).

The MICHIGAN STATE ECONOMIC RECORD

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Michigan Economic Indicators

Item	Year previous of latest month	Previous month	Latest month
Manufacturing workers:			
Average weekly hours, Michigan	42.0	40.9	42.6 (Dec.)
Average weekly hours, U.S.	40.9	40.2	40.8 (Dec.)
Average hourly earnings, Michigan ($)	9.07	9.99	10.30 (Dec.)
Average hourly earnings, U.S. ($)	6.97	7.59	7.69 (Dec.)
U.S. motor vehicle production (units)	791,521	602,777	613,274 (Feb.)
Michigan electricity usage (mil. kwh.)	5,763	5,860	5,714 (Nov.)
Industrial (mil. kwh.)	2,711	2,762	2,645 (Nov.)
Residential (mil. kwh.)	1,735	1,726	1.745 (Nov.)
Raw steel production:			
Michigan (000 net tons)	839	706	770 (Jan.)
United States (000 net tons)	10,701	10,180	10,590 (Jan.)
Consumer price index (1967 = 100)			
Detroit area	237.2	278.0	268.5 (Jan.)
United States	233.2	258.4	260.5 (Jan.)
U.S. wholesale price index (1967 = 100)	254.9	280.3	283.5 (Jan.)
Michigan farm prices received index (1967 = 100)	235	257	259 (Jan.)

SOURCES: U.S. Bureau of the Census; U.S. Bureau of Labor Statistics; Michigan Crop Reporting Service; Motor Vehicle Manufacturers Association, Inc.; American Iron and Steel Institute; and Energy Information Administration.

Contracts for Future Building, January 1980 and 1981

(Thousands of Dollars)

Area	Nonresidential			Residential			Total[a]		
	1979	1980	Percentage change	1979	1980	Percentage change	1979	1980	Percentage change
Ann Arbor	2,514	5,415	+ 115	1,816	5,809	+220	4,330	11,224	+159
Battle Creek	747	1,534	+ 105	518	592	+ 14	1,265	2,126	+ 68
Bay City	40	748	+1,770	252	226	− 10	292	1,010	+246
Detroit	54,121	55,477	+ 3	27,722	23,039	− 17	81,843	78,516	− 4
Flint	10,571	6,323	− 40	1,726	2,390	+ 38	12,297	8,713	− 29
Grand Rapids	40,432	5,379	− 87	7,105	4,410	− 38	47,537	8,789	− 79
Jackson	3,501	170	− 95	578	590	+ 2	4,079	760	− 81
Kalamazoo–Portage	1,577	910	− 42	3,167	1,369	− 57	4,744	2,279	− 52
Lansing–East Lansing	5,749	4,995	− 13	8,764	5,856	− 33	14,513	10,851	− 25
Muskegon–Norton Shores–Muskegon Heights	562	309	− 45	1,843	1,135	− 38	2,405	1,444	− 40
Saginaw	1,648	842	− 49	3,645	891	− 76	5,293	1,733	− 67
Michigan	130,443	85,089	− 35	75,551	54,757	− 28	205,991	139,846	− 32
United States	4,278,500	4,122,000	− 4	4,055,300	4,206,600	+ 4	8,333,800	8,328,600	—

SOURCE: F. W. Dodge Division of McGraw-Hill Information Systems Company, news releases.

NOTE: Battle Creek includes Barry and Calhoun counties; Detroit includes Lapeer, Livingston, Macomb, Oakland, St. Clair, and Wayne counties; Flint includes Genesee and Shiawassee counties; Grand Rapids includes Kent and Ottawa counties; Kalamazoo-Portage includes Kalamazoo and Van Buren counties; Lansing–East Lansing includes Clinton, Eaton, Ingham, and Ionia counties; and Muskegon–Norton Shores–Muskegon Heights includes Muskegon and Oceana counties.

a. Excludes nonbuilding construction contracts. This category comprises streets and highways, bridges, dams, reservoirs, river and harbor developments, sewerage and water supply systems, missile and space flight facilities, airports, utilities, and communication systems. For Michigan the 1980 and 1981 figures for nonbuilding construction contracts were $27,045,000 and $41,063,000 respectively, or an increase of 52 percent. U.S. figures for nonbuilding construction contracts were $2,606,700,000 and $2,138,700,000, or a decrease of 18 percent.

Year-to-Year Change in Selected Economic Indicators

Percentage change from previous year

Indicator	1980 Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	1981 Jan.
Civilian employment													
United States	+ 1.8	+ 1.6	+ 1.1	+ .9	+ .5	− .1	− .3	− .1	− .3	− .2	− .1	− .5	−
Michigan	− 2.1	− 3.1	− 4.3	− 4.4	− 7.3	− 6.5	− 7.3	− 4.1	− 5.1	− 5.2	− 5.7	− 4.5	− 3.8
Detroit area[a]	− 3.7	− 4.6	− 5.6	− 6.0	− 8.8	− 7.9	− 8.2	− 4.8	− 5.9	− 5.7	− 5.9	− 5.1	− 4.6
Outstate[b]	− .6	− 1.8	− 3.0	− 2.9	− 5.9	− 5.2	− 6.5	− 3.5	− 4.4	− 4.8	− 5.4	− 3.8	− 3.1
Wage and salary jobs[c]													
United States	+ 2.4	+ 2.3	+ 1.9	+ 1.7	+ .9	+ .1	− .2	−	+ .1	+ .2	+ .4	+ .5	+ .5
Michigan	− 2.9	− 3.5	− 3.8	− 4.9	− 7.0	− 6.9	− 7.2	− 4.8	− 4.8	− 3.9	− 2.5	− 2.5	− 2.0
Detroit area[a]	− 3.8	− 4.6	− 4.9	− 6.3	− 8.1	− 7.6	− 7.7	− 4.8	− 4.8	− 3.9	− 3.0	− 3.7	− 3.4
Outstate[b]	− 2.0	− 2.3	− 2.7	− 3.5	− 6.0	− 6.2	− 6.7	− 4.8	− 4.8	− 3.9	− 2.0	− 1.3	− .6
Average workweek[d]													
United States	− .7	− 1.0	− 2.0	+ 1.3	− 2.0	− 2.5	− 2.8	− 1.8	− 1.2	− 1.2	− .2	− .2	+ .3
Michigan	− 5.9	− 7.0	− 6.5	+ 6.4	− 6.4	− 5.5	− 3.6	− 2.2	− 1.2	+ .2	+ 5.4	+ 1.4	
Average weekly earnings[e]													
United States	+ 6.3	+ 6.1	+ 5.5	+ 9.6	+ 5.4	+ 5.3	+ 5.5	+ 7.0	+ 7.8	+ 8.3	+10.2	+10.1	+11.2
Michigan	− .6	− 1.5	+ .3	+14.6	− 2.2	+ 1.5	+ 3.4	+ 6.6	+ 8.9	+12.5	+18.3	+15.1	
Motor vehicle assembly													
United States	−38.2	−33.9	−36.6	−28.5	−50.2	−43.7	−48.2	−32.4	−17.6	−16.7	−13.4	+ .9	−13.4
Michigan	−40.7	−38.7	−49.7	−40.6	−62.1	−50.9	−54.4	−35.8	−20.1	−16.2	−19.7	+15.0	
General Motors	−24.0	−23.7	−45.0	−36.0	−60.9	−49.3	−44.9	−36.9	−22.7	− 9.2	−29.5	+ 8.3	
Ford	−52.7	−49.1	−47.2	−46.7	−54.1	−34.7	−69.0	−31.3	−15.7	−18.0	− 1.5	+42.8	
Chrysler	−77.5	−80.5	−74.0	−54.9	−77.1	−73.7	−86.2	−48.5	−16.5	+34.5	+ 5.2	+11.2	
Steel tonnage poured													
United States	− 3.6	− 2.2	− 9.0	−12.6	−27.9	−38.7	−42.5	−37.9	−26.3	−12.7	+ .6	+ 1.8	− 1.0
Michigan	−16.3	− 7.8	−20.7	−18.7	−42.9	−62.7	−54.8	−52.0	−33.4	−10.4	+ .8	− 6.0	− 8.3
Commercial electricity consumption													
United States	− 2.1	− .7	+ 1.7	+ 1.4	− .8	+ 1.1	+ 6.4	+ 7.9	+ 8.3	+ 4.3	+ 3.3		
Michigan	− 2.7	+ .7	+ .2	+ 3.9	− 2.8	− 4.4	+ 2.0	+ 4.6	+ 5.2	−	+ .1		
Industrial electricity consumption													
United States	− 1.0	+ 1.1	− 1.0	− 2.8	− 6.4	− 7.2	− 7.7	− 6.4	− 2.0	− 2.9	− 3.1		
Michigan	−16.0	−10.1	−14.7	−10.3	−26.1	−28.2	−19.8	−13.3	− 9.8	− 3.4	− 2.4		
Nonresidential construction contracts													
United States	+10	+12	+ 3	− 5	− 7	+ 6	+ 6	− 2	− 1	+ 6	+34	+37	− 4
Michigan	+28	−33	−24	+ 1	+15	+ 8	+31	−38	−41	+10	+100	+13	−35
Residential construction contracts													
United States	− 9	− 5	−34	−39	−44	−30	−11	−17	− 2	− 3	+24	+33	+ 4
Michigan	−27	−13	−37	−69	−55	−55	−37	−38	−22	+ 5	+ 8	+17	−28
Nonbuilding construction contracts													
United States	−20	−60	−36	−50	−33	−24	−41	+76	+ 3	−13	−26	−18	−18
Michigan	−76	−49	+28	−51	−41	−24	−29	− 8	+35	−11	+53	+13	+52
Retail sales													
United States	+12.1	+14.6	+ 3.5	+ 4.9	+ 4.3	+ 1.9	+ 9.2	+ 3.4	+ 5.4	+ 8.4	+ 4.8	+ 8.5	
Michigan	+ 8.9	+ 7.3	− 3.6	− 1.8	− 4.1	− 5.9	+ 6.1	− 2.4	+ 1.2	+ 3.6	− .7	+ 2.4	
Detroit area[a]	+ 9.6	+ 7.4	− 2.0	+ .1	− 4.0	− 4.0	+ 8.9	+ 1.5	+ 6.4	+10.4	+ 4.0	+ 5.2	
Detroit city	+20.0	+14.1	+ 4.6	− .7	− 6.8	−10.6	− 4.2	− 9.6	− 3.7	+ 1.0	−12.5	−12.1	
Suburbs	+ 7.5	+ 6.0	− 3.4	+ .2	− 3.4	− 2.6	+11.7	+ 3.7	+ 8.1	+12.2	+ 7.2	+ 8.4	
Outstate[b]	+ 8.0	+ 7.2	− 5.5	− 4.0	− 4.3	− 8.3	+ 2.8	− 6.7	− 4.6	− 3.9	− 6.4	− 1.2	
Consumer price index													
United States	+13.9	+14.1	+14.7	+14.7	+14.4	+14.3	+13.2	+12.8	+12.7	+12.6	+12.6	+12.4	+11.7
Detroit[a]	+15.7	+15.1	+14.8	+16.4	+16.1	+19.2	+15.6	+14.8	+16.0	+16.3	+15.2	+15.7	+13.2

SOURCE: Michigan Employment Security Commission, special release; Bureau of Labor Statistics, *The Employment Situation* (monthly); Motor Vehicle Manufacturers Association, special release; American Iron and Steel Institute, special release; Energy Information Administration, special release; F. W. Dodge Division of McGraw-Hill Information Systems Company, news releases (monthly); and Bureau of the Census, *Monthly Retail Trade*.

a. Wayne, Oakland, Macomb, Livingston, Lapeer, and St. Clair counties.
b. Michigan minus Detroit area.
c. The number of wage and salary jobs, except agricultural, reported by employers.
d. Average hours worked by manufacturing production workers.
e. Average earnings among manufacturing production workers.

Quarterly Motor Vehicle Employment and Assembly

Item	1978			1979				1980			
	2	3	4	1	2	3	4	1	2	3	4
EMPLOYMENT[a]											
Checker											
Michigan	1,118	1,084	1,140	1,207	1,194	1,182	1,099	982	803	735	882
Chrysler											
Michigan	82,799	75,187	81,664	75,316	70,238	58,182	55,456	47,273	43,235	40,733	44,452
United States	136,158	125,989	135,997	125,899	118,532	99,754	98,228	86,341	78,908	73,248	80,321
Ford[b]											
Michigan	127,148	126,300	135,377	132,298	129,526	117,630	111,790	104,321	92,458	86,528	100,033
United States	239,517	233,314	253,536	245,253	240,054	211,763	196,038	181,595	160,226	144,068	172,827
General Motors											
Michigan	278,000	267,000	289,000	295,000	296,000	291,000	288,000	267,000	237,000	220,000	253,000
United States	619,000	594,000	643,000	644,000	650,000	582,000	602,000	561,000	499,000	469,000	538,000
ASSEMBLY											
Dearborn	70,007	39,072	83,017	96,572	92,774	85,970	68,819	65,971	70,823	49,852	54,856
Detroit	140,723	54,857[c]	89,563[c]	130,475[c]	113,866[c]	56,399[c]	78,055[c]	57,044[c]	40,016[c]	32,540[cR]	102,410[c]
Detroit (truck)	11,443	11,142	30,753[c]	33,693[c]	28,503[c]	12,861[c]	16,534[c]	14,812[c]	5,865	1,687	4,717
Flint	104,042	76,157	109,192	115,405	110,135	56,914	90,222	69,179	65,568	54,201	71,213
Flint (truck)	116,436	103,549	104,839	114,846	95,075	60,985	75,541	70,123	19,975	12,605	68,449
Hamtramck	86,545	56,808	54,230	44,901	62,806	15,345	30,134	1,031[c]	c	c	c
Kalamazoo	1,036	809	1,019	1,134	1,268	1,203	1,161	770	810	762	855
Lansing	110,381	62,327	116,726	130,644	130,363	72,684	96,143	104,913	82,558	56,769	85,367
Pontiac	87,334	61,666	82,652	91,712	85,977	46,578	61,082	50,974	30,102	26,077	39,831
Pontiac (bus & truck)	67,569	61,741	72,398	77,144	73,922	51,628	42,135	33,850	24,376	21,831	21,295
Warren (bus & truck)	94,415	72,181	84,504	76,365	48,873	5,027	19,043	14,783	28,537	16,498[R]	17,363
Wayne	76,599	63,214	55,607	50,477	46,765	34,081	28,800	27,840	37,401	24,039	67,854
Wayne (truck)	56,436	48,390	52,388	56,052	51,994	21,305	34,256	25,355	7,751	11,890	21,362
Wixom	47,639	36,508	46,902	51,132	36,527	20,013	32,604	8,724	6,896	15,393	19,914
Ypsilanti	73,733	57,178	38,891	38,797	75,420	73,508	70,507	84,598	83,147	66,919	80,400
Total Michigan											
Passenger car	798,039	508,596	654,346	751,250	755,901	462,695	557,527	471,044	417,321	326,552[R]	522,700
Bus and truck	341,141	297,003	368,325	358,100	298,367	151,806	187,509	158,923	86,504	64,511[R]	133,186
Total United States											
Passenger car	2,656,507	1,850,701	2,398,411	2,411,307	2,482,907	1,655,546	1,884,756	1,783,732	1,632,826	1,259,897	1,697,792
Bus and truck	1,019,266	851,996	982,232	1,024,655	916,996	529,092	564,118	499,525	350,607	307,817	476,234
Total Canada											
Passenger car	345,842	229,593	297,157	307,823	281,806	171,427	227,966	225,969	228,428	162,183	228,393
Bus and truck	185,031	120,199	180,355	200,162	190,698	107,988	135,532	146,015	136,314	95,798	144,764

SOURCE: Ward's *Automotive Reports;* Motor Vehicle Manufacturers Association of the United States, Inc., P-I report; and companies.

a. Average monthly wage and salary employment of companies with assembly plants in Michigan; includes nonautomotive.

b. Excludes Ford Aerospace and Communications Corporation and finance and insurance subsidiaries.

c. Chrysler's Jefferson Avenue plant was converted to truck production in September 1978. It was returned to car production in August 1980 after having been closed since March 1980. Chrysler's Hamtramck plant closed January 4, 1980.

R: Revised.

Electronics and Education in the Midwest

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In the last two decades electronics has become one of the most exciting industries of all time because of its diversity, the many challenges it offers, and its potential for spectacular growth. This situation has been brought about by a *new electronics* that originated about 20 years ago, based on sophisticated applications of recent developments in science and technology.

Education has an increasingly important role in the new electronics. To the individual, formal university training is essential because the concepts involved are too complex to be acquired by home study and on-the-job experience. A year of graduate training is almost a necessity for those who wish to participate in the technical aspects of the most promising areas, and a Ph.D. degree is desirable for the person who aspires to be an expert.

This means that the university is acquiring a new significance. Industry is discovering that for electronic activities involving a high level of scientific and technological creativity, it is more important to be located near an educational institution (a center of brains) than near markets, raw materials, suppliers, transportation, or factory labor. There are a number of reasons for this. Universities are the sources of the highly trained young people who represent the most important raw material going into creative electronics. Universities, through their research activities, are sources of ideas; a few of these are directly exploitable commercially, and others contribute to an understanding that stimulates innovation on the part of industry, particularly nearby industry. The faculty members of a good university provide a panel of experts possessing a wide range of highly developed skills available on a consulting basis to aid industry with its problems; thus even a small company near a university can have access to specialized knowledge in depth on a basis that it can afford. A university close at hand provides educational opportunities for employees, so that those with good potential but inadequate training can be upgraded, and all can be kept abreast of new scientific developments. Finally, in an intangible but very real way, a university provides an atmosphere that stimulates creativity and makes a community attractive to scientifically minded individuals.

When these factors are viewed in perspective, it is seen that education is perhaps the most significant factor affecting the future of electronics. Education is a resource of first importance to that part of the electronics industry that is growing through creative activity. Thus, the Boston area may be stagnant in many fields of industry, but it is one of the liveliest places in the country for the new electronics. This is easily traceable to the Massachusetts Institute of Technology and Harvard University. Similarly, a spectacular development of creative electronics has taken place on the San Francisco Peninsula during the last dozen years. Stanford University is at its center, and this is not an accident. The university has over 400 graduate students in electrical engineering and trains more Ph.D.s than any other school in the country.

Electronics in the Midwest lacks the explosive character of electronics on the Pacific Coast and in New England. This region does not lead in the development of new ideas and in the opening up of new fronts of activity. This is because electronics in the Midwest has for over a quarter century been more interested in the exploitation and the refinement of existing ideas and existing product lines than in opening up new fields of activity. It has been more concerned with trying to make money by redesigning established products than with attempting to grow from the exploitation of new products. It has not developed a strong component of research and as a result has spawned nothing comparable to the Bell Telephone Laboratories, David Sarnoff Laboratory, Lincoln Laboratory, or General Electric Research Laboratory. In short, the Midwest is still preoccupied with the *old* electronics.

Now why has it lagged in the *new* electronics? In searching for the answer one starts with the period before World War II. At that time the Midwest was the great center of the nation in electronic manufacturing, with emphasis on consumer items in which practical design know-how, materials cost, and efficiency in mass production were important. The technology of these products was stabilized, and they offered only limited opportunity for creative work growing out of new developments in science. As a result, formal graduate training was not required of the engineers and scientists. When the war brought microwave radar, servo-mechanisms, sonar, the first solid state devices (diodes), and computers, the electronics industry of the Midwest was unprepared. It did not include many people who were technically qualified to take a leading part in this type of work, and it did not have industrial research laboratories capable of pioneering these new developments. Neither did it have government laboratories such as the Naval Research Laboratory. It did not develop war research laboratories in electronics associated with universities, as typified by the Radiation Laboratory at MIT, the Radio Research Laboratory at Harvard, the Underwater Sound Laboratory at Harvard, and the Airborne Instruments Laboratory at Columbia.

As a result, most of the Midwest electronics industry participated only at second hand in the new electronics of World War II. Leadership came largely from the East Coast, and when the Midwest did participate it was largely in the design and production of equipment based on concepts, techniques, and laboratory models originated in the East by groups more deeply oriented in science. By and large, midwestern electronics simply did not have the scientific competence to stand on its own feet with respect to the war-developed techniques and devices. The lack of scientific depth in midwestern electronics made it difficult or impossible to use fully the region's productive capacity in getting these new devices produced.

At the end of the war electronics in the Midwest, having been only superficially inculcated with the new ideas that originated in World War II, reverted to its old interests emphasizing the engineering, design, and production of products for the consumer market. This was profitable as long as television was being introduced into new areas,

but it had limited opportunity for growth once television was established in every community. In recent years, sales of television and radio receivers have not been growing much, and the Japanese may well get an increasing share of the total in the future. In the lush days of television, too few midwestern organizations used their television profits and engineering organizations to establish a strong position in other areas of electronics with greater potential.

In contrast with the postwar course of events in the Midwest, the electronics industry of the East Coast continued its interest in the further development of the new concepts introduced into electronics during the war and strengthened research and technical staffs that were oriented toward science. As a result, the East is now strong in the new areas of electronics with almost unlimited growth possibilities.

In view of the above, one may wonder why western electronics has grown so rapidly during the last fifteen years, when it was much less important than midwestern electronics before and during the war. The answer is that after the war some strongly science oriented concerns began to develop on the West Coast. They prospered and demonstrated the possibilities of growth and profits through developing products in which a high proportion of the value was in the engineering involved, in contrast with the principal products of the Midwest where the value resided to a much greater degree in material and labor costs. Thus the West, without a tradition, got started in a new and forward looking pattern at the end of the war.

In contrast with the East and West Coasts, the electronics industry of the Midwest has not been much interested in the person with the Ph.D. and what he or she can contribute to the opening up of new frontiers. It has failed signally to exploit the educational resources and the educational institutions that are available to it. It was not willing during the past fifteen years to put much of its own money into the development of new kinds of products; in fact until recently it has not shown much interest in research and development even when the government would pay the bill. To be brutally blunt, the major path of electronics took off in a new direction in the decade 1940–1950, but little of the electronics industry of the Midwest followed. There are, of course, individual exceptions to these general statements, but in broad terms what is said here is true. The Midwest somehow has not developed much enthusiasm for staffing high concentrations of people who have the highly technical background required to do creative work in the new and rapidly growing areas of electronics. This is emphasized by the fact that there are various companies with headquarters in Chicago that do their creative work elsewhere in the country, while examples of the reverse are scarce indeed.

The basic problem of midwestern electronics is what academics call anti-intellectualism. In broad terms, the Midwest is more interested in those with practical know-how than in those whose strength is depth of training in advanced science and technology. Not enough midwestern companies know how to make effective use of the egghead type. As a result, midwestern companies do not really fight for the people with advanced degrees in electronics being produced by their own universities, let alone by universities in other parts of the country. The consequence is that the midwestern schools do not produce such people in large numbers. Stanford alone (and Stanford is not a large school) produces more people each year with advanced degrees in electronics than do all of the institutions in the state of Illinois. Put another way, California produces more people with advanced degrees in electronics each year than do the states of Illinois, Wisconsin, Indiana, Michigan, Minnesota, Missouri, and Iowa all put together. Under these circumstances it is no wonder that many of the brightest graduates from midwestern schools are recruited by West Coast colleges, complete advanced training there, and devote their subsequent careers to advancing electronics in the West. Such institutions as MIT and Harvard also transplant a group of the brightest young people from the Midwest to the East Coast.

Another facet of this anti-intellectualism is that the electronics industry in the Midwest has not adequately appreciated the educational institutions in its midst and has not made full use of them. It is surprising that there are not more electronic companies of the creative type clustered around outstanding midwestern universities. This is the result of both lack of vision on the part of industry and of lack of leadership on the part of the institutions.

These remarks are deliberately provocative. The electronics industry of the Midwest is in a rut and needs to be jolted out of it. It lacks the glamour and the growth potential that it should have. Electronics in the Midwest has a long tradition and a successful past. It can have a worthwhile future and can participate more in the good new things that are ahead in the field of electronics during the next several decades, but only by developing with the times. If it just plods along, the Midwest will become increasingly the peon group in the electronics industry, which does hard, unexciting work and makes a living, while at the same time the East Coast and particularly the West Coast electronics industries will have all of the fun and most of the growth. If the Midwest continues in the present pattern, it will continue to be the happy hunting ground where bright young people are recruited to go to the East and West Coasts to make the electronics industries there steadily stronger and ever growing.

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